Digitalization in Agricultural Business Systems and Agricultural Product Processing Industries

#DigitalAgriculture

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AGENDA

- Introduction
- Numerous Challenges in the Agrifood System That Digital Technologies Can Address
- What are appropriate digital technologies?
- Digital Applications in Agricultural Business Systems in the Supply-Chains (Distribution, mid-stream to downstream)
- Use of AI, machine learning & risk management algorithms for supply chain logistics and analytics
- Challenges & Constraints in Adopting Digital Innovations
- References

Source: CTA Space https://www.youtube.com/watch?v=g8tHedBgrRA&t=1s

1. Numerous Challenges in the Agrifood System That Digital Technologies Can Address

Macro Level

Food Supply Increase→ By 2050, there is a necessity to boost the global food supply by over 50% (FAO, 2016).

Agricultural Productivity Growth→ Small farms need to enhance productivity by 200%, while commercial farms require a 20% increase (IFPRI).

Micro Level (Farm-level)

- Adapting to Climate Change;
- Addressing Environmental Degradation;
- Enhancing Land Productivity;
- Reducing Labor Intensity;
- Expanding Farming Areas;
- Minimizing Food Loss and Waste;
- Managing Labor Availability and Efficiency.

Approach

The development and application of digital technologies should be driven by these challenges, aiming to provide effective solutions that address specific problems within the agrifood system.

Agriculture has historically depended on discoveries and innovations to make big disruptive strides: Mendel's laws, hybrid seed, mechanization, fertilisation, modern dwarf varieties, synthetic pesticides, biotechnology, precision farming, etc.

Twenty-first Century innovations

Digitalization in agriculture (production, post-harvest)/Smart farming/ Knowledge Technologies

Biotechnology for crop & animal improvement, including nutrition

Novel environments for farming

Product integrity and fraud prevention

Supply chain logistics, infrastructure and risk management

Novel food (e.g. Alternative proteins)

Disruptive Innovations are needed:

- To increase farm productivity
- To make more food available
- To improve agricultural sustainability &
- To improve nutrition security

- Will digital technologies be the big disrupter in the 21st C?

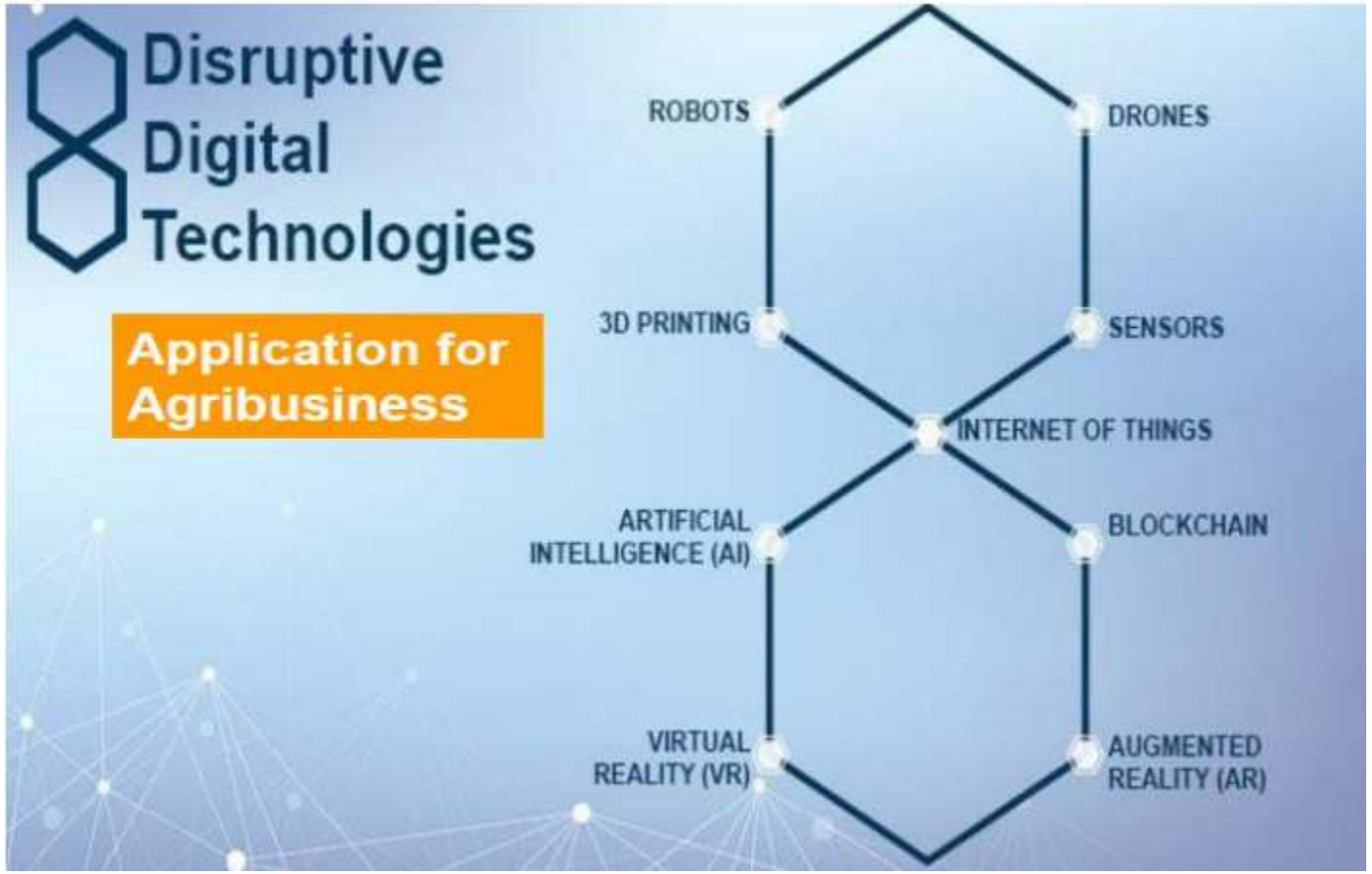
Source: Montesclaros, J. M. L., Teng, P., & Caballero-Anthony, M. (2022) https://www.youtube.com/watch?v=g8tHedBgrRA&t=1s

2. What are appropriate digital technologies?

- Two possible perspectives:
  - Viewpoint 1 -- What are available digital technologies?
  - Viewpoint 2 – Which parts of the agrifood system/ supply chain to use DTs?

2. What are appropriate digital technologies?

- Viewpoint 1 → What are available digital technologies?



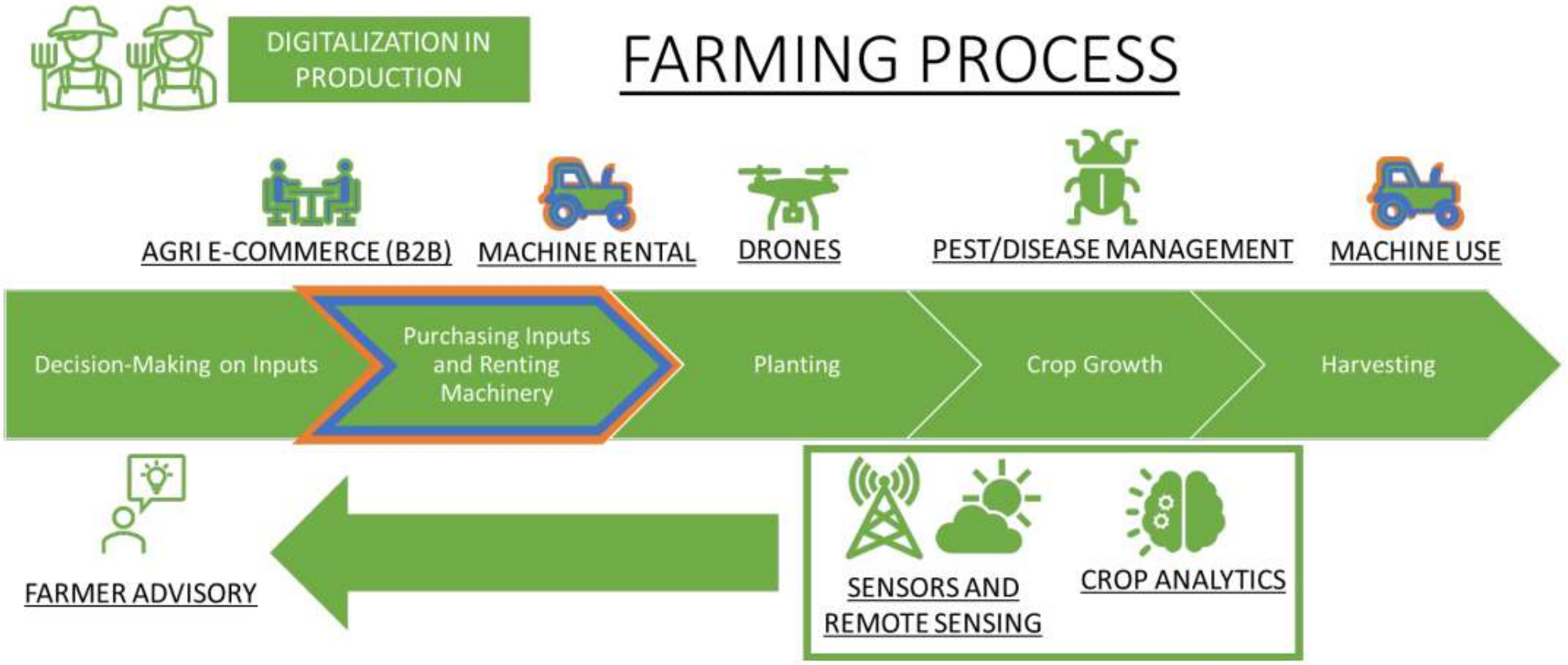
Source: Courtesy of Michael Dean, AgFunder, 2020

2. What are appropriate digital technologies?

- Viewpoint 2 → Parts of the agrifood system/ supply chain to use digital technologies

Source: Montesclaros, J. M. L., Teng, P., & Caballero-Anthony, M. (2023)

Digital Applications in Production and Processing ("AGTECH" or Smart Farming)



Source: Montesclaros, J. M. L., Teng, P., & Caballero-Anthony, M. (2023)

Theoretical Yield	• Genetically determinants
Potential Yield	• Defining factors: CO2, Radiation, Temperature, Crop features
Water & Nutrient-Limited Yield	• Limiting factors: Water, nutrients
Actual Yield	• Reducing factors (loss): Biotics (weeds, insect pests, diseases); abiotics

Source: Montesclaros, J. M. L., Teng, P., & Caballero-Anthony, M. (2022)

New farming systems: Controlled environment vegetable farming using precision agriculture concepts

- ‘Plant Factory’ technology (Urban) new farming systems called “ PFAL ” or Plant Factory with Artificial Light
- Use of digital Internet of Things (IoT) systems which link environmental sensors to crops to decision algorithms which optimize growth
- Example: HortiPolaris, China, uses “Digital Twins” (systems models) to guide optimization of plant growth in indoor tomato farm by manipulating the environment and inputs

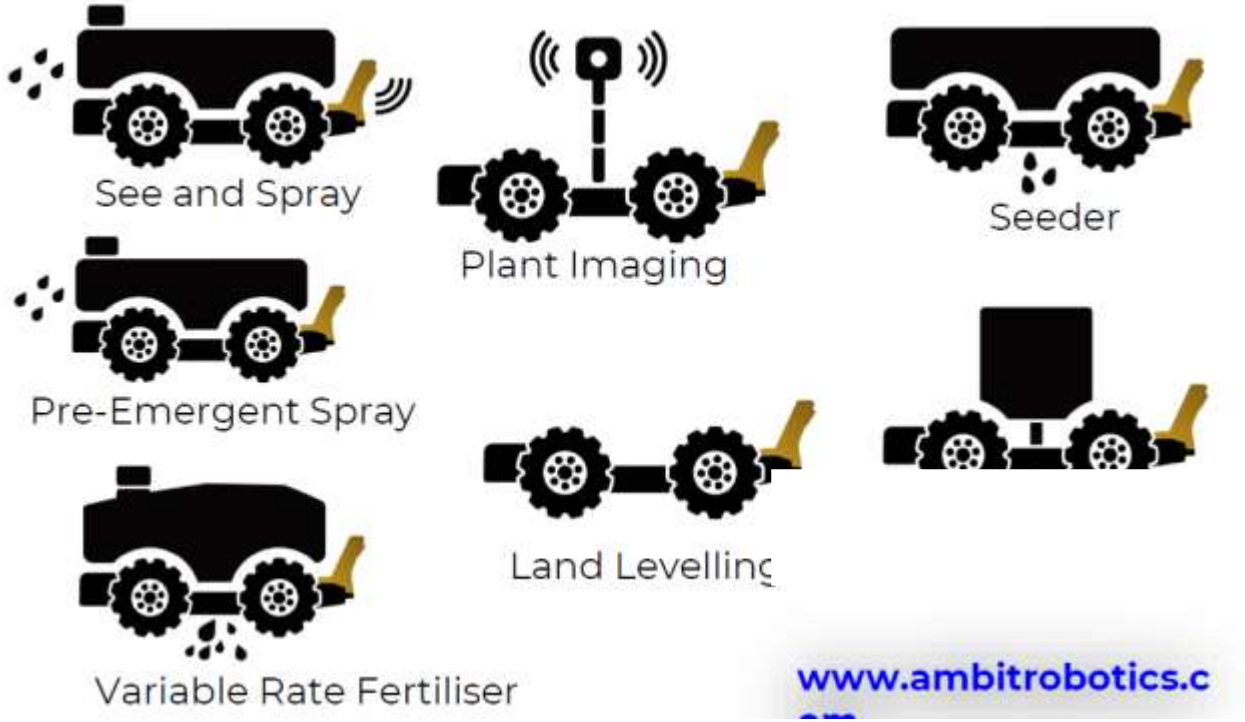
- Farm 1- “Panasonic” Indoor Farm

- Farm 2- “Archisen”

Source: Montesclaros, J. M. L., Teng, P., & Caballero-Anthony, M. (2022)

ROBOTS for smallholders

- Reduce drudgery
- Increase accuracy at scale
- Reduce cost of operation
- Reduce dependency on labour



Modular Applications

- Autonomous
- Portable
- Accessible
- Modular

Source: http://www.ambitrobotics.com/

Digital Applications in Supply-Chains (Distribution, mid-stream to downstream)

- Connecting farmers to businesses, consumers & other stakeholders

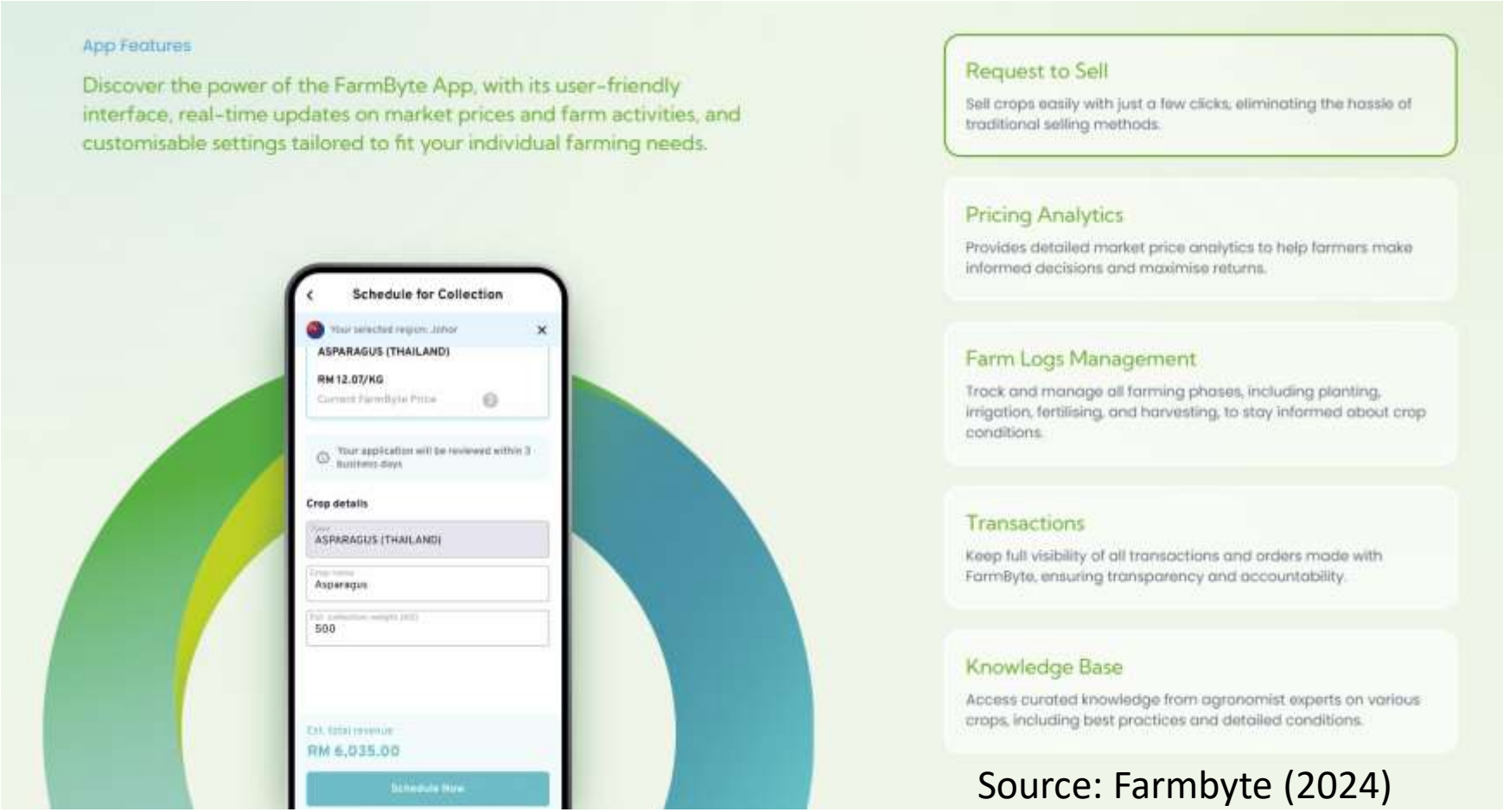
Source: Adapted from Montesclaros, J. M. L., Teng, P., & Caballero-Anthony, M. (2023)

- Example: Farmbyte
- Farmbyte & Airasia and launches agriculture – ecommerce platform

Source: Farmbyte (2024); Newsroom Asia (2020)

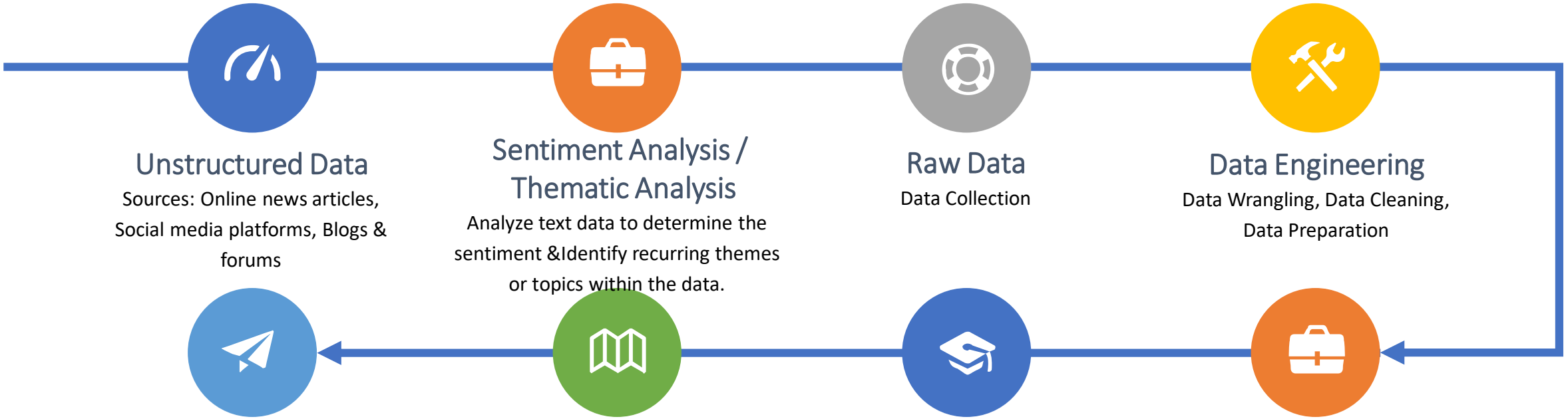
Digital Applications in Supply-Chains (Distribution, mid-stream to down-stream)

Connecting farmers to businesses, consumers & other stakeholders



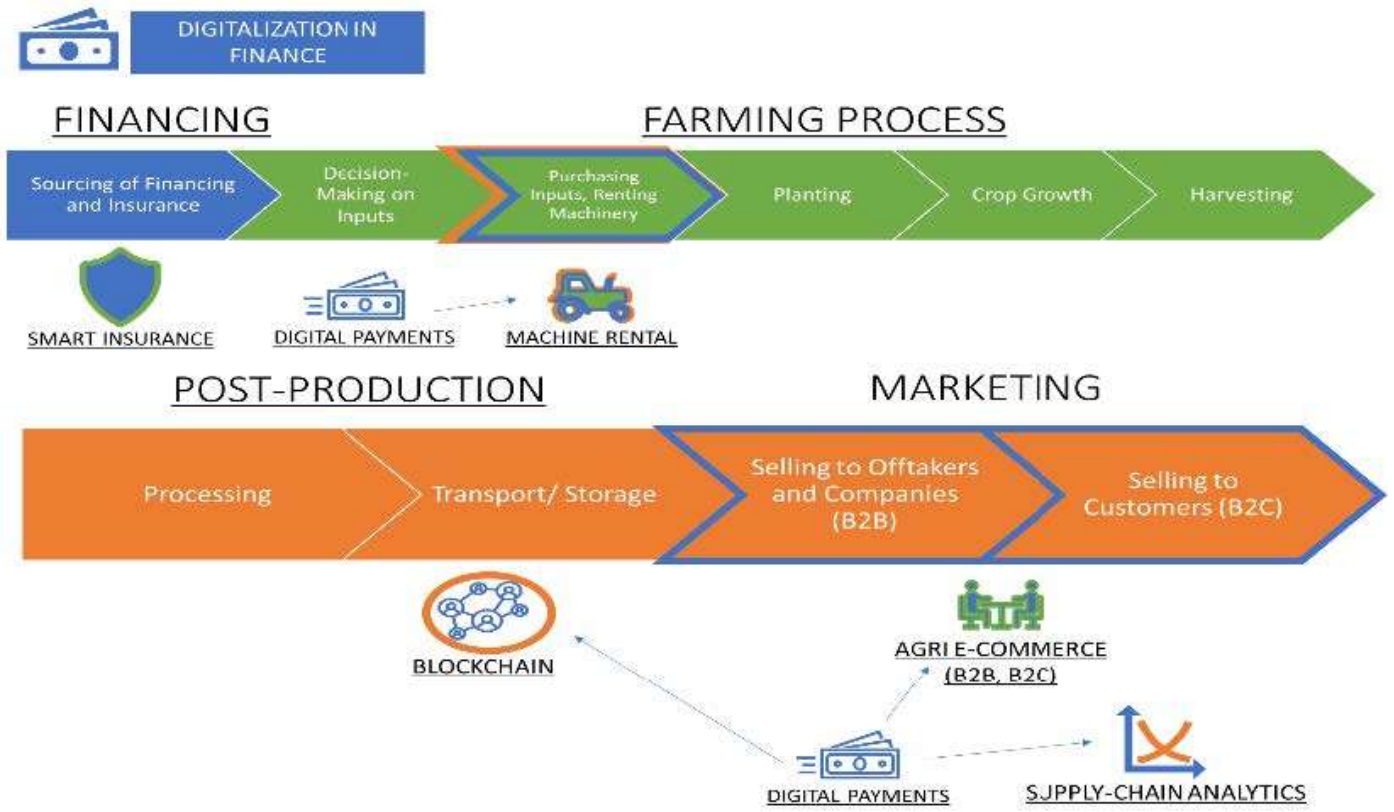
Source: Farmbyte (2024)

Use of AI, machine learning & risk management algorithms for supply chain logistics and analytics



Source: Adapted from Montesclaros, J. M. L., Teng, P., & Caballero-Anthony, M. (2023)

Financial Digital Applications (Fintech)



- Financialization of the “Agrifood system’ provides many intervention points across the whole value chain for digital tech.

Challenges & Constraints in Adopting Digital Innovations

Infrastructure Development

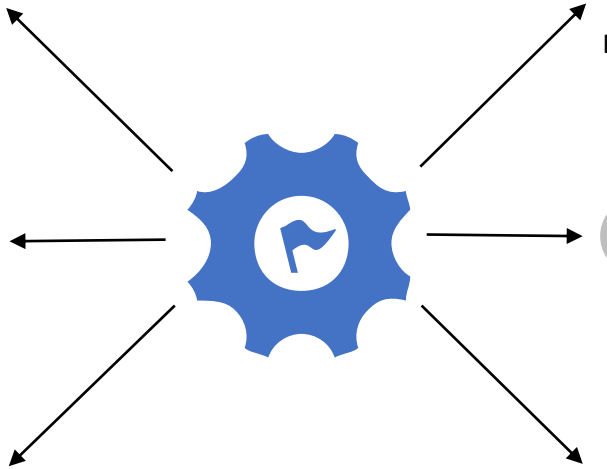
Telecom and ICT Infrastructure: Adequate telecommunications and ICT infrastructure are essential for supporting digital agriculture, yet many regions lack sufficient connectivity

Data Management Challenges

Harmonization and Standardization: Diverse data sources require harmonization and standardization to ensure interoperability between different systems and service providers

Technology Access and Transfer

Affordability and Accessibility: High costs of digital technologies can be prohibitive for small-scale farmers, limiting access to innovations that could enhance productivity.
Extension Advisory Services: Effective technology transfer mechanisms are needed to support farmers in adopting new tools through education and advisory services



Readiness and Adoption by Farmers

Farmer Readiness: Many farmers may not be fully prepared to adopt digital innovations due to a lack of awareness, skills, or resources needed to implement new technologies effectively

Relevance and Problem-Solving

Better Solutions: Digital innovations must offer clear advantages over existing non-digital methods to justify their adoption

Regulatory Freedom and Compliance

Regulatory constraints, such as those governing the use of drones or data privacy laws, can hinder the deployment of certain digital technologies

References

- Farmbyte website (2024). Accessed on 19/10/2024. https://farmbyte.com/solution#farmerApp
- Montesclaros, J. M. L., Teng, P., & Caballero-Anthony, M. (2023). Digital technology utilization in the agriculture sector for enhancing food supply chain resilience in ASEAN: Current status and potential solutions.
- OURFARM connects agriculture producers directly to businesses (2020). Accessed on 19 October 2024 https://newsroom.airasia.com/news/ourfarm-connects-agriculture-producers-directly-to-businesses#gsc.tab=0
- https://events.development.asia/learning-events/asia-and-pacific-food-security-forum-2024
- Paul Teng, J.M.L. Montesclaros & Mely Caballero-Anthony (2022), Digital Technology in Agriculture, Centre for Non-Traditional Security Studies, S. Rajaratnam School of International Studies, Nanyang Technological University Singapore. Presented at Asia-Pacific Rural Development and Food Security Forum 2022

Acknowledgement: All sources for this presentation has been cited or/and have been requested from the private sector entities.

Thank You

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Moving towards sustainable agriculture using a digital agriculture framework

R. Arief Firmansyah

Disampaikan pada seminar nasional dengan tema Digitalisasi dalam sistem usaha pertanian dan industri pengolahan hasil pertanian
Di Universitas Wiraraja
Oktober, 2024

Kondisi Pertanian Indonesia

INDONESIA POSITIF

1000 Hektare Lahan Pertanian di Sidoarjo Terdampak Kekeringan

Rudi Mulya

Jumat, 25 Agustus 2023 - 11:06 | 39.74k

Kabupaten Bandung Barat

Limbah Industri Cemari Sungai Citarum Bikin Sengsara Petani-Penjala Ikan

Whisnu Pradana - detikJabar

BISNIS PANGAN

BRIN Ingatkan Krisis Pangan: Degradasi Lahan dan Ancaman Petani

27 Februari 2024, 01:26

CONNECT WITH US

233,018 Fans

11,767 Pengikut

813 Pengikut

78,300 Pelanggan

Berita Lain

Kemenag Perkuat Sk
Murur dan Siapkan
Tanazul Saat Haji 202

14 Oktober 2024, 10:43

Jakarta, Aktual.com – Badan Riset dan Inovasi Nasional (BRIN)

BPS Sebut Luas Lahan Pertanian Kian Menurun

CNN Indonesia

CNN Indonesia Home Nasional Internasional Ekonomi Olahraga Teknologi Otomotif Hiburan Gaya Hidup

Doom Spending Taipan

Peneliti nyatakan pertanian monokultur kurang tepat diaplikasi di Indonesia

SEPUTAR SULTENG POLHUKAM EKONOMI DAN KEUANGAN HUMANIORA LINTAS JAGAD ARTIKEL ADVETORIAL/RILIS JURNA

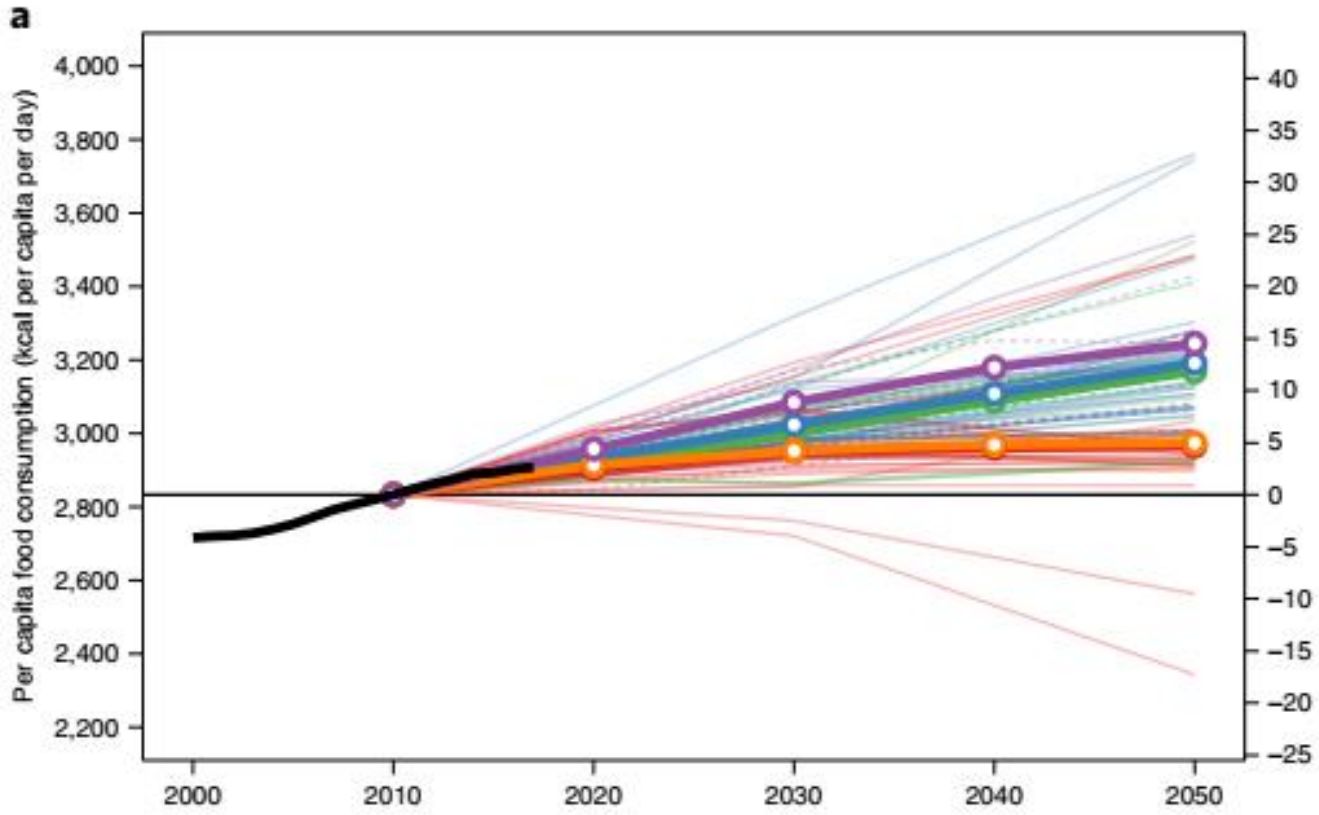
THE CONVERSATION

Disiplin ilmiah, gaya jurnalistik

Cari analisis, penelitian, akademisi...

Pemilu 2024 Kesehatan Pendidikan + Budaya Politik + Masyarakat Sains + Teknologi Lingkungan Isu Anak Muda Ekonomi In English

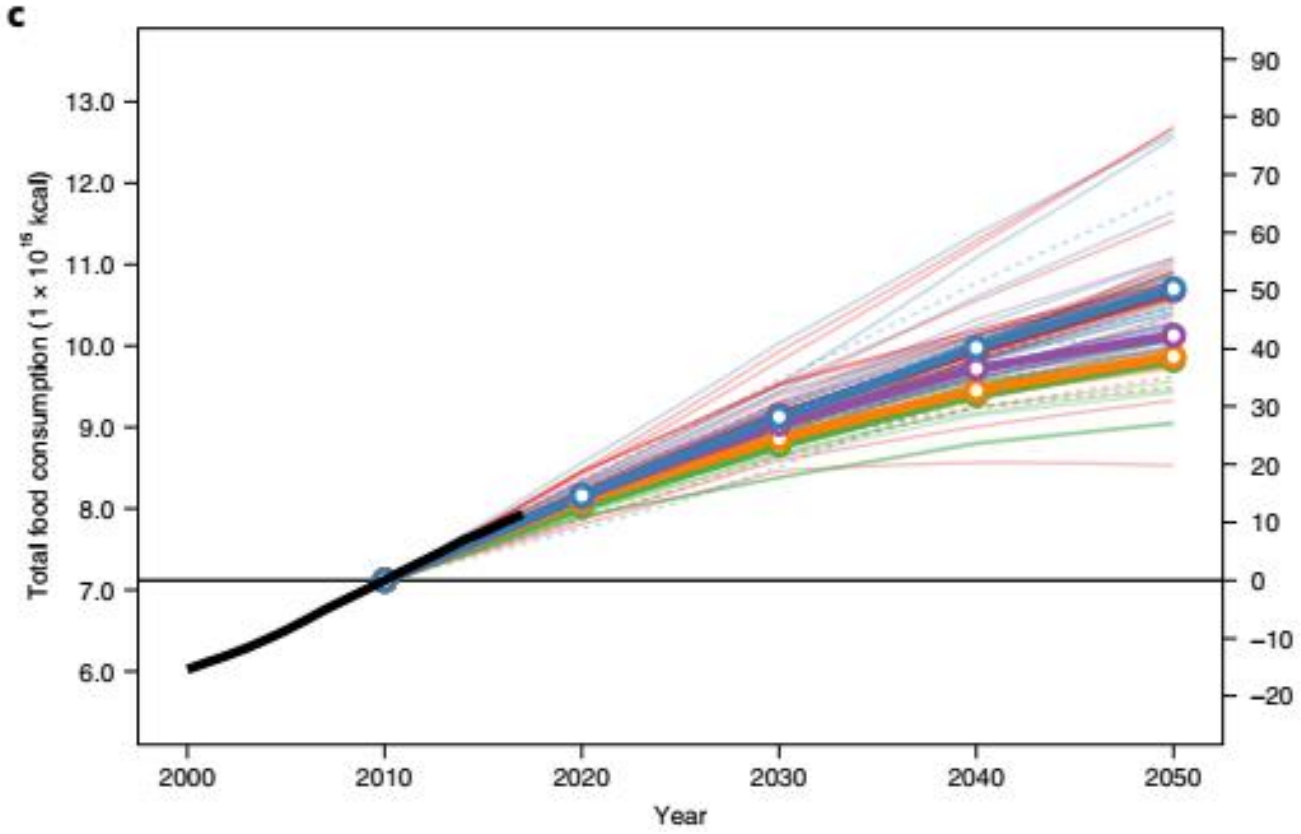
Analisis: petani terus 'dicekoki' pestisida



Proyeksi di masa depan, dibutuhkan kurang lebih 3000 s.d 3200 kcal per capita per hari

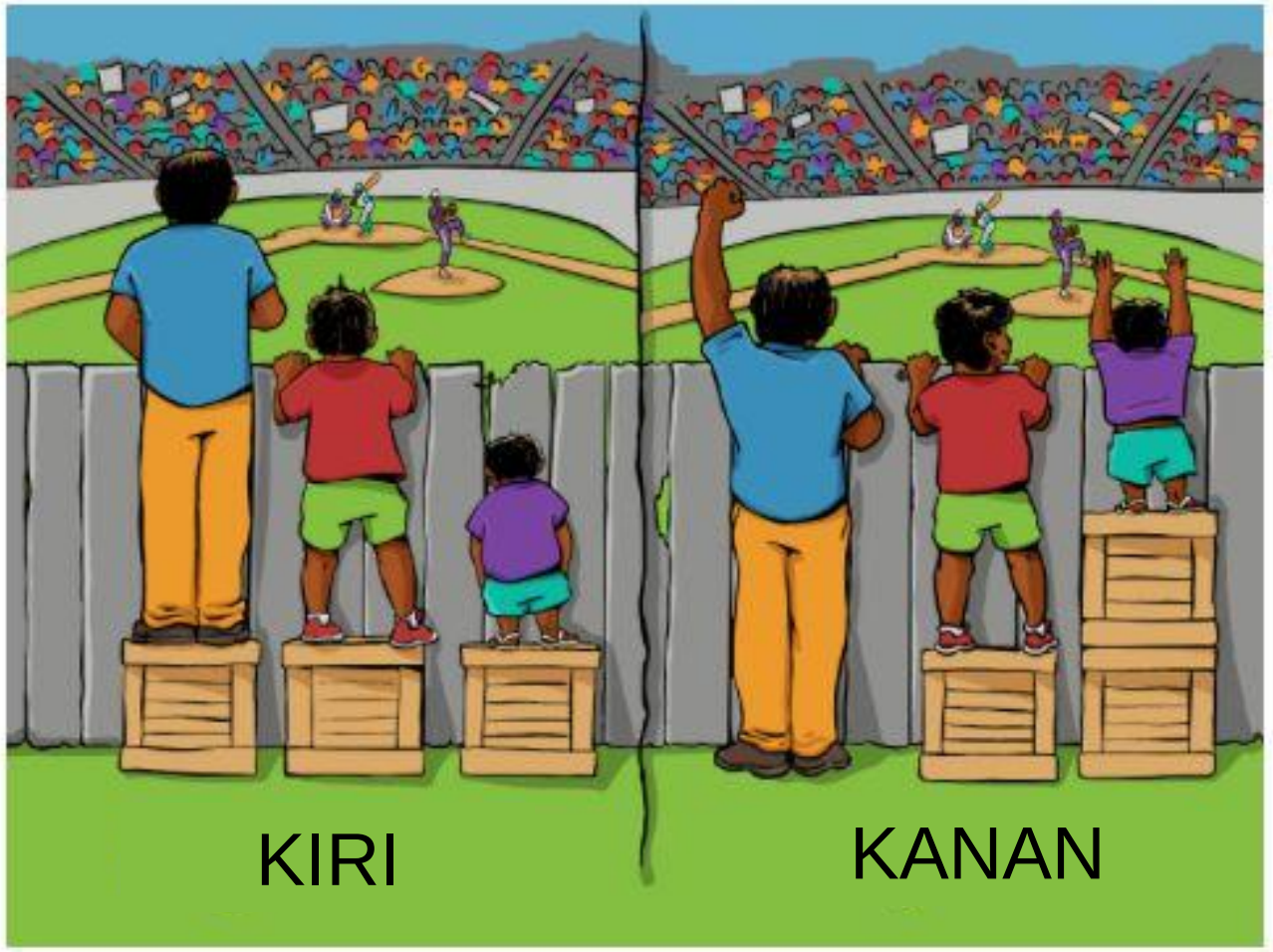
Proyeksi di masa depan, dibutuhkan
Lebih dari 10 x 10^{15} kcal
total konsumsi pangan
Setara dengan

$\approx 8 \cdot 10^{9}$ ton



- To face the challenges of climate change, soil degradation, and food security, a Sustainable agriculture framework is a promising idea.
- Sustainable agriculture was defined as *management procedures that work with natural processes to conserve all resources, minimize waste and environmental impact, prevent problems, and promote agroecosystem resilience, self-regulation, evolution, and sustained production for the nourishment and fulfillment of all*
- Term of “work with natural processes” was translated as maintaining the diversity of soil and crop attributes through monitoring inputs (water and nutrients) that supporting by variable-rate technology

An illustration …
Which one do you think is correct?



4 general classes of technology that accelerating sustainable agriculture

1. **Data :** Sensing the system
2. **Control :** Responding to insight
3. **Modelling :** linkages between data and control; source of decision making
4. **Networking and communication :** increasing the flow of data and insight

❑ Primary data

1. Primary data are those that are collected for the first time
2. These are in the form of raw materials
3. Collecting primary data is quite expensive in terms of time and money
4. Source from the sensor, a vast array of sensors, Internet of Things

❑ Secondary data

1. Refer to the data that some other person has already collected
2. These are in the finished form
3. Requires less time and money; hence, it is economical
4. Source from omics data, monitors, remote sensing (satellite, airborne, or ground-based Devices), radio frequency identification (RFID) scanners, and other data such as GPS

Objective measurement and conversion of sufficient information can potentially create value in the following ways:

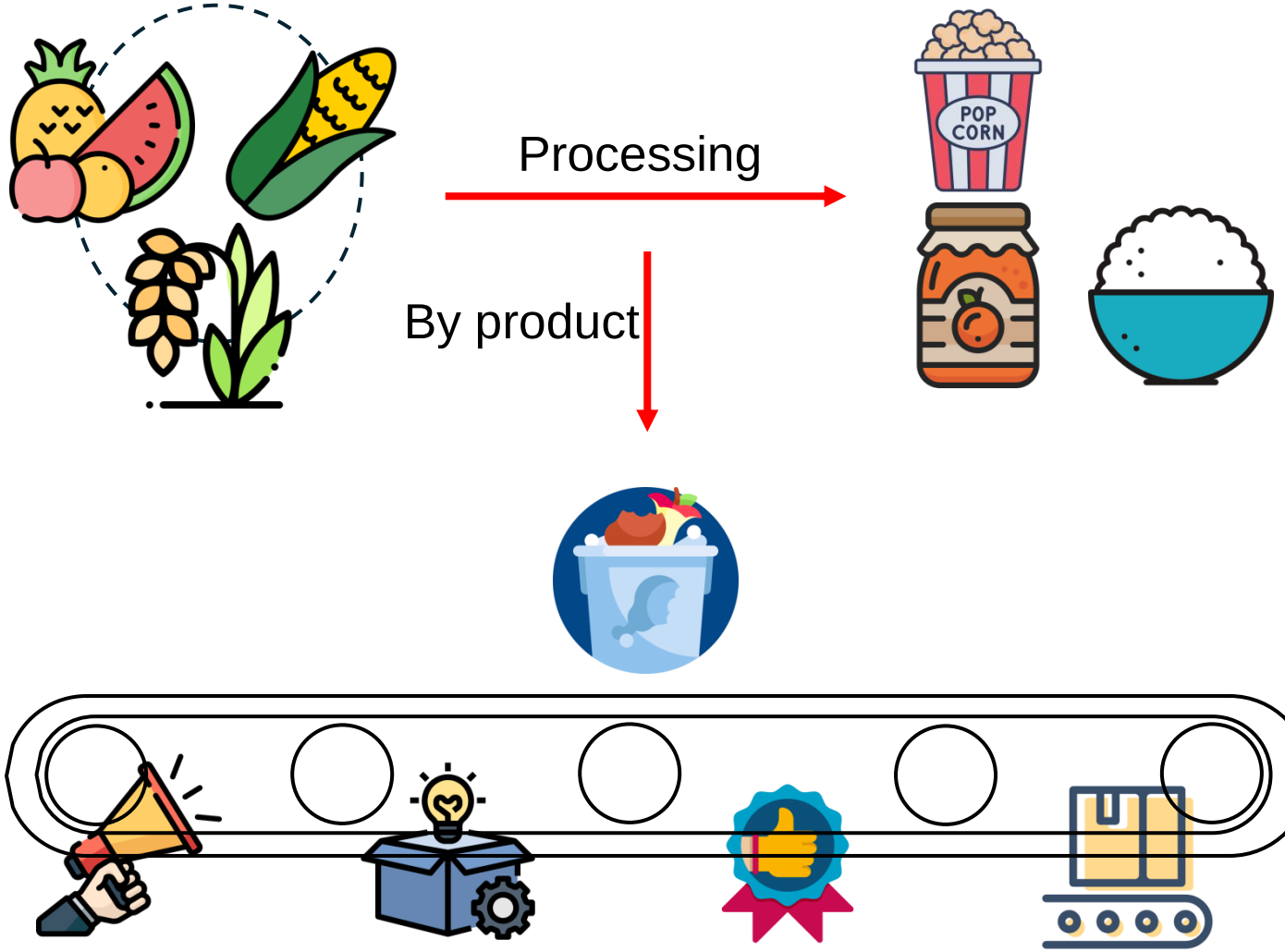
1. Improving production efficiency
2. Preserving value through environmental considerations
3. Increasing value through precision processing
4. Establishing traceability of products
5. Equity valuation based on data

- Good data without better control hardly generates achieved value
- Here is an example of technologies to improve control of an action or process

1. **Robotics**: machine operation in processing to improve precision and reduce labor cost; differentiated line production to optimize stock raw material for targeted consumer
2. **Digital trading**: data-intensive valuation to account for differential quality; consumer prevalence; and provenance
3. **RFID**: traceability of product for halal or organic product

- The integration of multiple data sources and control is linked through analysis for decision-making.
- This transition turns the concept of precision agriculture into digital agriculture, which emphasizes turning precision into decision-making.
- Another transformation involves shifting the paradigm from hindsight to foresight.
- These transformations are made possible with the support of big data and artificial intelligence.

Business process of AGROINDUSTRY



Practical application of digital technologies in packaging field

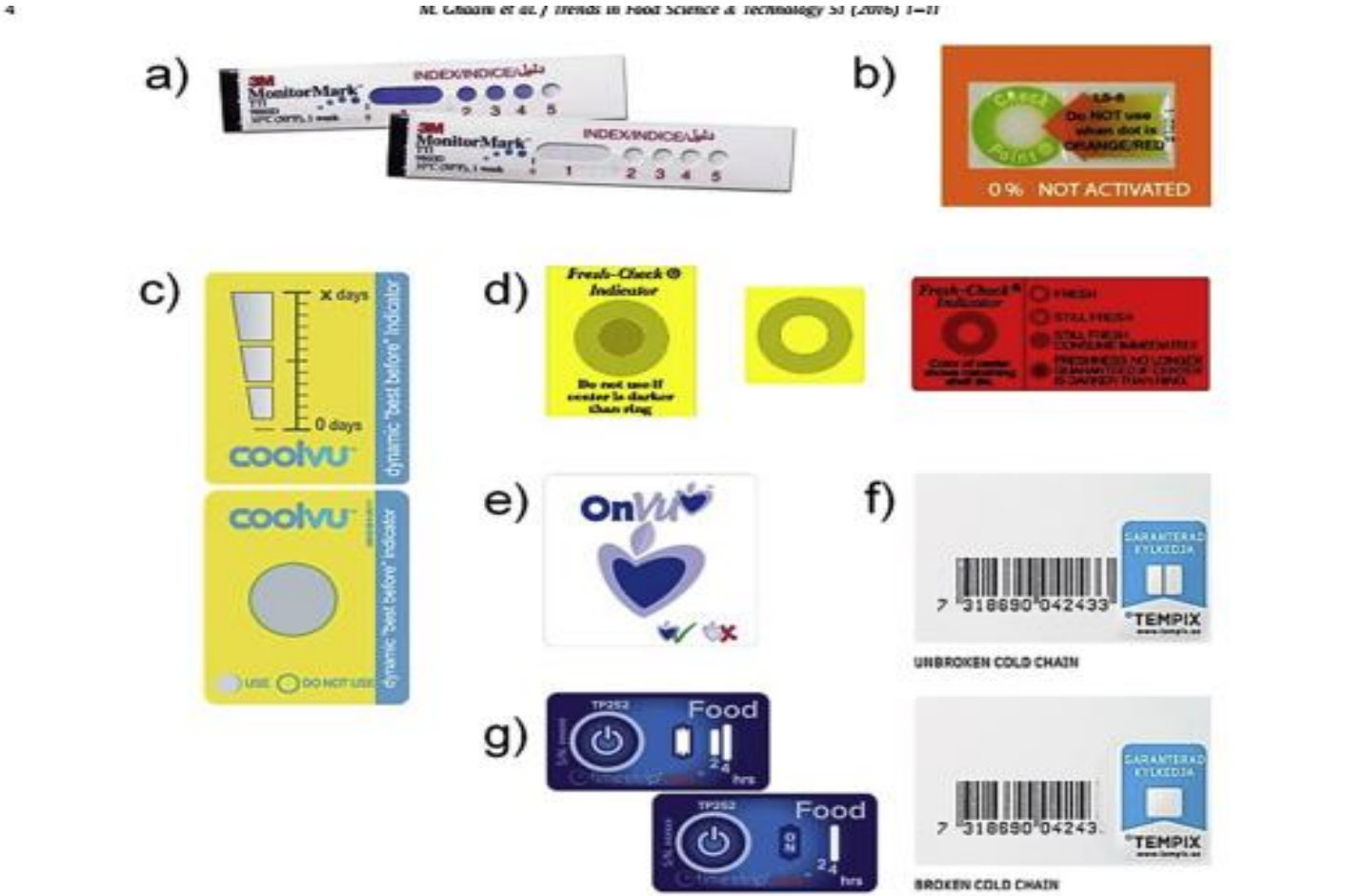
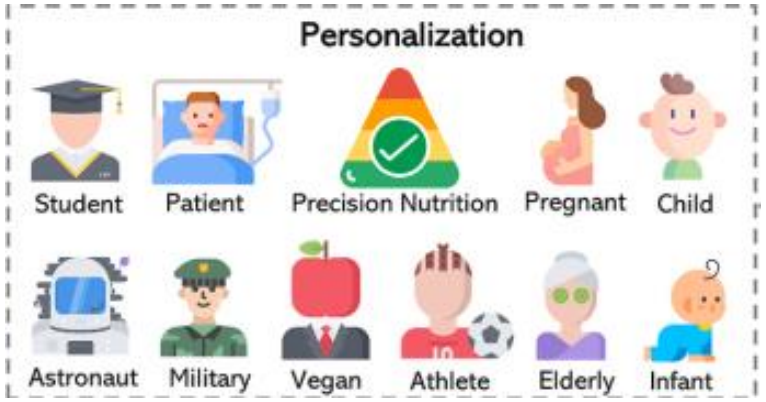
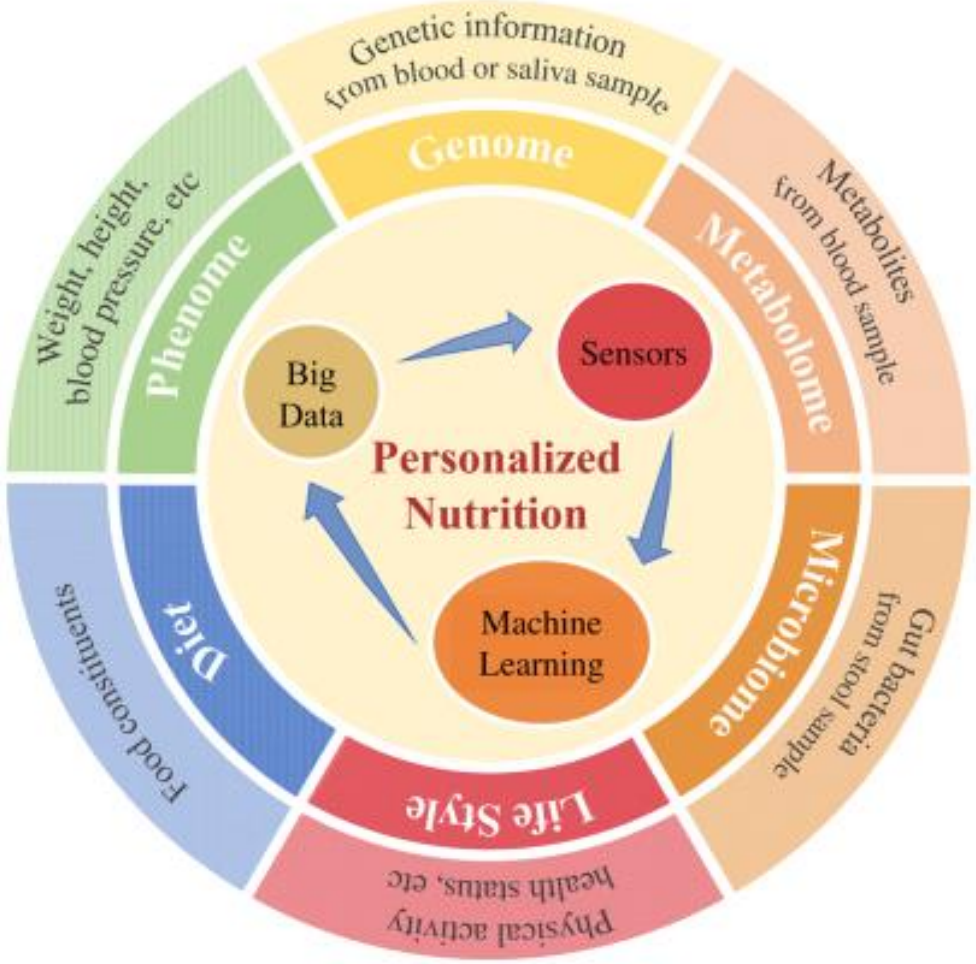
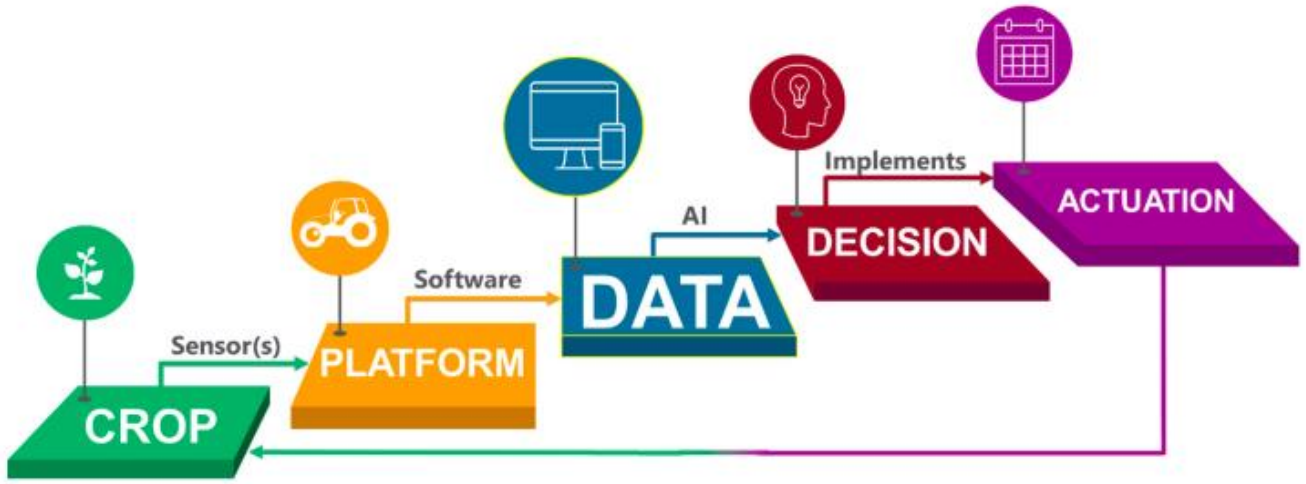


Fig. 2. Examples of time-temperature indicators: a) Monitor Mark™ by 3M (USA) (http://3m.com); b) Fresh-Check® by Lifelines Technologies Inc. (USA) (http://fresh-check.com/); c) CoolVu™ by Freshpoint (Switzerland) (http://www.freshpoint-tti.com/product/coolvu.aspx); d) Checkpoint® by Vitsab International AB (Sweden) (http://vitsab.com/index.php/tti-label/); e) OnVu™ by Freshpoint (Switzerland) (http://www.freshpoint-tti.com/links/default.aspx); f) Tempix® by Tempix AB (Sweden) (http://tempix.com/the-indicator/); and g) Timestrip® by Timestrip Plc (UK) (http://timestrip.com).

Personalized nutrition is the driving force for the emergence of precision processing







Small actions that can support sustainable agriculture include

1. Ensuring data integrity through good data collection practices and continuity.
2. High-quality data will lead to better decision-making, made easier with the assistance of artificial intelligence.

References

Cook, S., Jackson, E. L., Fisher, M. J., Baker, D., & Diepeveen, D. (2021). Embedding digital agriculture into sustainable Australian food systems: pathways and pitfalls to value creation. International Journal of Agricultural Sustainability, 20(3), 346–367. https://doi.org/10.1080/14735903.2021.1937881

Liu, F., Li, M., Wang, Q., Yan, J., Han, S., Ma, C., … McClements, D. J. (2022). Future foods: Alternative proteins, food architecture, sustainable packaging, and precision nutrition. Critical Reviews in Food Science and Nutrition, 63(23), 6423–6444. https://doi.org/10.1080/10408398.2022.2033683

Ghaani, M., Cozzolino, C. A., Castelli, G., & Farris, S. (2016). An overview of the intelligent packaging technologies in the food sector. Trends in Food Science & Technology, 51, 1–11. https://doi.org/https://doi.org/10.1016/j.tifs.2016.02.008

Liu, X., le Bourvellec, C., Yu, J., Zhao, L., Wang, K., Tao, Y., Renard, C. M. G. C., & Hu, Z. (2022). Trends and challenges on fruit and vegetable processing: Insights into sustainable, traceable, precise, healthy, intelligent, personalized and local innovative food products. Trends in Food Science & Technology, 125, 12–25. https://doi.org/https://doi.org/10.1016/j.tifs.2022.04.016

Saiz-Rubio, V., & Rovira-Más, F. (2020). From smart farming towards agriculture 5.0: A review on crop data management. In *Agronomy* (Vol. 10, Issue 2). MDPI. https://doi.org/10.3390/agronomy10020207

van Dijk, M., Morley, T., Rau, M.L. et al. A meta-analysis of projected global food demand and population at risk of hunger for the period 2010–2050. Nat Food 2, 494–501 (2021). https://doi.org/10.1038/s43016-021-00322-9